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Functional outcome of distal humerus fractures treated by orthogonal locking compression plating: a short-term study

Shivakumar Jeyarajan[1], Dinesh Loganathan[2]*

[1]Department of Orthopaedics, ACS medical College and hospital, Chennai, Tamil Nadu, India
[2]Department of orthopaedics, Chettinad hospital and research institute, kelambakkam, Tamil Nadu, India

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***Correspondence:**
Dr. Dinesh Loganathan,
E-mail: dineshchmc@gmail.com

ABSTRACT

Background: In Indian settings, the incidence of distal humeral fractures is associated with motor vehicle accidents and simple accidental falls. The treatment of these fractures continues to remain challenging due to anatomical factors. The present study was carried out to evaluate the functional outcome of distal humerus fractures treated with bicolumn locking compression plates applied orthogonally.
Methods: This prospective study was carried out among 15 patients who were diagnosed with fracture of distal humerus. A detailed clinical examination and radiological assessment were done to evaluate the fracture pattern. In complex articular fractures, Chevron V shaped olecranon osteotomy was done. In other cases, routine approaches like TRAP, paratricipital or Triceps splitting approach were used.
Results: The most common type of fracture observed was C2 (53.4%) and was associated with fracture of distal radius (26.6%) followed by fracture metacarpals (13.2%). Olecranon osteotomy was the most common surgical approach (40%). Majority of the participants in both the age groups equally showed excellent and good outcomes (42.8% and 37.5% respectively) while males showed excellent outcomes (55.6%) compared to females (16.7%).
Conclusions: It is inferred that distal humerus fractures with intraarticular extension can be successfully treated with locking compression plates applied orthogonally. However, a long-term follow-up and a larger sample study is needed to further validate our findings.

Keywords: Humerus fractures, Olecranon osteotomy, Bicolumn locking compression plate, Motor vehicle accidents

INTRODUCTION

Fractures of the distal humerus accounts for 2-6% of all fractures and one-third of all humeral fractures.[1] In Indian settings, the incidence of distal humeral fractures is increasingly bimodal in distribution with motor vehicle accidents being the major cause in young population whereas simple accidental falls are the cause in elderly population. Despite various advances, distal humeral fractures remain one of the most challenging injuries to treat. Composite problems in distal humerus fracture management include frequent articular involvement, metaphyseal comminution, bone loss and osteopenia. The fore mentioned issues along with the complex three-dimensional geometry pose great difficulties in internal fixation. Further prolonged immobilization results in poor outcomes like stiffness. Traditional methods of internal fixation are associated with non-union and high failure rate. Attempts to achieve painless, stable, yet mobile elbow requires a systematic approach.

The treatment of these fractures is still debated and an ongoing quest for the ideal solution still remains. The chances of functional impairment and deformity are very high following conservative treatment of distal fractures of the humerus. Principles of good anatomical alignment,

absolute stabilization and early mobilization are far more important in elbow joint than in any other joint. Open Reduction and Internal Fixation (ORIF) of the fracture allows the surgeon to restore anatomical alignment of the fracture fragments and permit early range of motion exercises which may aid in the return of a functional range of motion of the elbow postoperatively. Various forms of internal fixation have been evolved over time in an attempt to best restore anatomical alignment of the distal humerus.

The anatomical location to place the plates on the distal humerus has recently been debated throughout the literature with the majority of authors currently recommending at least two plates be utilized to provide adequate stability and allow for adequate restoration of anatomy. The guidelines for fixation of distal humeral fractures have been a gold standard till now with 2 plates places at a 90° angle to one another (orthogonal/perpendicular plating). Using these fixation techniques authors have reported satisfactory outcomes in 80% to 85% of patients due to early mobilization and stable bi-column construct[2]. As a result of ongoing search for a more secure technique the concept of parallel plating (180°) was later evolved. This technique involves placing one plate along the medial column of the distal humerus and the other plate along the lateral column with the screws in the distal fragment interdigitating with each other in the distal fragment restoring the 'tie beam arch' of the distal humerus. The problems encountered during parallel plate technique is extensive soft tissue dissection and chances of neurovascular injuries. Therefore, the need for evaluating the 'gold standard' bi-column construct at various angles may prove beneficial in achieving the desired functional outcome in the post-operative period. The present study was carried out to evaluate the functional outcome of distal humerus fractures treated with bicolumn locking compression plates applied orthogonally.

METHODS

The present study was carried out as prospective study in the Department of Orthopaedics of a tertiary teaching institution for a period of three years between 2017 and 2019. All the patients who were diagnosed with fracture of distal humerus were evaluated for selection criteria.

Inclusion criteria

Intra articular fractures of distal humerus, age >18 years, AO Types C1, C2 and C3 and closed injuries.

Exclusion criteria

Patients with head injuries and vascular injuries, open fractures, severe intra-articular comminuted fractures in elderly, patients with medical comorbidities and not willing to participate.

A total of 15 patients who were diagnosed with fracture of distal humerus during the study period were selected for the study. The participants were selected by purposive sampling.

Approval was obtained from the institutional ethics committee prior to the commencement of the study. Each participant was explained in detail and informed consent was obtained prior to the data collection.

A structured proforma was used to obtain information regarding the mechanism of injury and associated injuries. A detailed clinical examination and radiological assessment were done to evaluate the fracture pattern, deformity and neurovascular status. The injured limb was immobilized in above elbow plaster slab until surgery.

Surgical technique

The study participants were administered with general or regional anaesthesia and were positioned in the lateral position, with the involved limb supported over bolsters in OT table. Through a midline posterior skin incision subcutaneous and deep fascia were incised. Before proceeding further, the ulnar nerve was identified, dissected out and retracted gently with an umbilical cotton tape. Triceps muscle was identified and released on either side from the intermuscular septum. In complex articular fractures, Chevron V shaped olecranon osteotomy was done incompletely with saw and completed with an osteotome to visualize the articular surface. In other cases, routine approaches like TRAP, paratricipital or Triceps splitting approach were used. Olecranon osteotomy was used to achieve wide exposure of intra articular fragments in type C fractures.

Orthogonal plating technique

Initially the articular fragments were aligned and provisionally fixed using k wires. The distal fragment was temporarily fixed with k wires in both columns to ensure restoration of the anatomy of distal humerus. The length of the plates was chosen based on sufficient fixation proximal to the fracture lines. To prevent excessive diaphyseal stress, medial and dorsolateral plates were placed of different lengths. Initially the dorsolateral plates were applied and non locking 3.5 mm cortical screw was inserted to fix the plate to the bone. The screws were all directed from posterior to anterior. Additional screws were inserted in a lateral to medial direction for the condyles. The placement and length of screw were confirmed with image intensifier during movement of the elbow to ensure screws are not in the joint. The medial plate was positioned on medial ridge slightly dorsal to intermuscular septum with distal tip reaching down to insertion of medial collateral ligament. The longest possible screws were inserted in distal fragment. After fixing the fracture segments, Tension Band Wiring of osteotomized olecranon was carried out either with two K wires or a 6.5 mm Cancellous screw. Meticulous repair of soft tissues was done in layers and closed with a suction drain. Routine post-operative protocol was followed. The participants

were advised to follow up at 3rd, 6th and 12th week. At each follow up patients were evaluated clinically and the functional outcomes were measured in terms of Mayo elbow performance score (MEPS). Excellent and good outcomes indicated success of the intervention.

RESULTS

The present study was carried out among 15 patients who were diagnosed with fracture of distal humerus. Majority of the patients belonged to the age group of 31-40 years (26.6%) with a mean age of 36 years (Table 1).

Figure 1: Preoperative radiographs showing fracture distal humerus with intra articular extension.

Figure 2: Postoperative radiographs showing orthogonal bicolumn LCP Plating.

Most of the participants were males (60%) and motor vehicle accidents were the most common mechanisms of injury (66.5%). (Table 2)

The most common type of fracture observed was C2 (53.3%) and was associated with fracture of distal radius (26.6%) followed by fracture metacarpals (13.2%). Olecranon osteotomy was the most common surgical approach (60%). (Table 3)

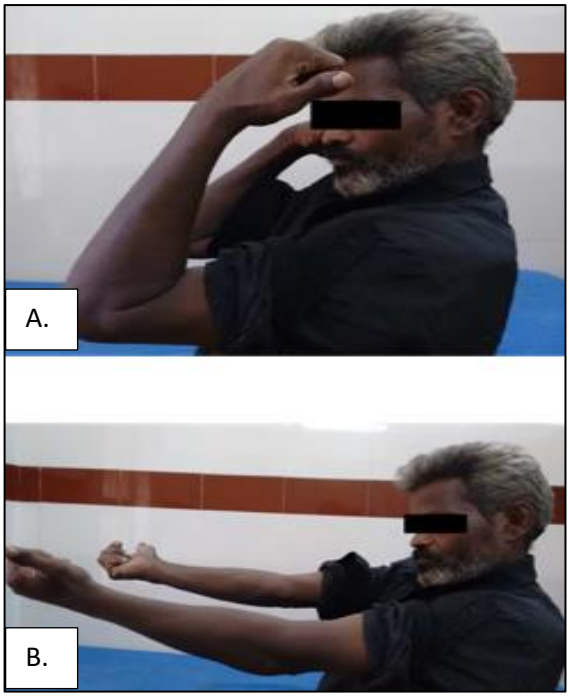

Figure 3: Clinical ROM. (A) flexion and (B) extension of elbow 6 months after surgery.

Table 1: Age group.

Age (years)	No. of patients	Percentage
20 to 30	3	20
31 to 40	4	26.6
41 to 50	3	20
51 to 60	4	26.6
>60	1	6.6

Table 2: Mode of injury, fracture classification and surgical procedure.

Mode of injury	No. of patient	%
Motor vehicle accidents	10	66.5%
Simple Fall	3	20%
Fall from height	1	6.6%
Assault	1	6.6%
Fracture type (AO-OTA)	**No. of patient**	**%**
C1	5	33.33
C2	8	53.33
C3	2	13.33
Surgical procedure	**No. of patients**	
Olecranon osteotomy	9	
Paratricipital	4	
Triceps splitting	1	
TRAP	1	

Table 3: Associated injuries.

Associated injuries	No. of patients
Fracture of distal radius	4
Fracture shaft of contralateral humerus	1
Fracture of pubic rami	3
Fracture metacarpals	2
Median nerve palsy	1

The post-operative outcomes were categorized as excellent, good, fair and poor. Majority of the participants in both the age groups equally showed excellent and good outcomes (42.8% and 37.5% respectively) while males showed excellent outcomes (55.6%) compared to females (16.7%). However, the observed difference was statistically not significant.

DISCUSSION

The treatment of distal humerus fractures with intraarticular extension by bicolumn locking compression plates applied orthogonally is studied in detail. The options for articular fractures are wide and are continuously refined over time. The treatment is difficult because of complex three-dimensional geometry. Poor functional outcomes like stiffness, non-union and implant failure makes these fractures challenging to treat. In this study the objective was to assess the functional outcome of the fracture patients strictly adhering to principles of good anatomical alignment, absolute stabilization and early mobilisation.

The mean age of the study participants was 36 years which is comparable to the study conducted by Shin et al whose average age is 42 years.[3] The younger age group had more successful outcomes (88%) than the elderly group. This may be attributed to the poor bone quality and noncompliance of patients leading to poor functional outcome like stiffness. The male patients had a better success rate than a female patient in the present study. Similar study by Liu et al proposed that might be due to better bone quality and active postoperative mobilization exercises in the young male patients.[4] Among the various approaches, Chevron olecranon osteotomy was widely used which produced a good success rate (88.9%) and paratricipital approach with a success rate of 50%. A study by Elmadag et al showed olecranon osteotomy provided better outcome than paratricipital approach in their study of 54 patients.[5]

Anterior transposition of ulnar nerve was done in all 15 patients in the present study, out of which two patients had ulnar neuropraxia which recovered completely in six months. In a study by Ring et al the complications of olecranon osteotomy reported were bursitis, hardware prominence, broken or migrated k wire.[6] In the present study, one case of hardware prominence was encountered. In the study by Qi-X et al 21 cases of distal humerus fractures were operated using paratricipital approach one case of myositis ossificans was reported.[7] In this study out of the four cases, one case developed stiffness due to heterotopic ossification. In the study by Babhulkar et al 80 cases of intraarticular fracture were operated through orthogonal plating and had excellent outcome in 86% of cases.[8] Kaiser et al study showed 22 patients treated with orthogonally applied LCP plates.[9] The mean MEPS score was 84.7. The complications reported in this study were ulnar sensory neuropathy which recovered incompletely in one case. All patients had achieved stable reduction and union during follow up.

In the study by Holub et al the outcomes of conventional reconstruction plates and LCP were compared; excellent results were achieved with the use of locking compression plates particularly in intraarticular distal humerus fractures.[10] The average operating time was 123 minutes using conventional plates. The present study had an average time of 100 minutes which may be attributed to the anatomically fit pre-contoured plates which does not need any contouring to fix with the bone. Lee et al compared the outcomes of parallel and orthogonal plating technique using distal humerus LCP and no significant difference in outcomes of both techniques were noted.[11] Stoffel et al reported the same result in their study of parallel versus perpendicular locking plate systems in comminuted distal humerus fractures.[12] No intergroup differences noted in terms of operating time, time to union and functional recovery were reported. Ian et al too had reported no difference in MEPS score, flexion extension arc and operating time.[13] Athwal et al studied the outcomes of 37 patients treated by distal humerus LCP by parallel plate technique and five patients out of 24 had postoperative nerve injuries (16%).[14] In our study only one case of postoperative nerve injury was seen. This may be attributed to the safe and easier dissection required in orthogonal plating technique compared with parallel plating technique.

CONCLUSION

Incidence of complex distal humerus fractures among younger population is on the rise due to increasing motor vehicle accidents. Absolute stability of the system allows early postoperative rehabilitation and thence a better functional outcome. Good to excellent functional outcome was achieved in >80% of the study group in terms of arc of motion and stability. Locking compression plates applied orthogonally can be a successful technique for internal fixation of these complicated fractures when its principles are strictly adhered to. In the management of complex articular fractures orthogonally applied locking compression plates provide results comparable with locking compression plate using parallel plate technique. It is inferred that distal humerus fractures with intraarticular extension can be successfully treated with locking compression plates applied orthogonally. However, a long-term follow-up and a larger sample study is needed to further validate our findings.

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